

(12) UK Patent Application (19) GB (11) 2 298 026 (13) A

(43) Date of A Publication 21.08.1996

(21) Application No 9602817.0

(22) Date of Filing 12.02.1996

(30) Priority Data

(31) 9502922

(32) 15.02.1995

(33) GB

(71) Applicant(s)

Francis Xavier Kay
The Old School House, Church Hill, AKELEY,
Buckinghamshire, MK18 5HB, United Kingdom

(72) Inventor(s)

Francis Xavier Kay

(74) Agent and/or Address for Service

Forrester Ketley & Co
Forrester House, 52 Bounds Green Road, LONDON,
N11 2EY, United Kingdom

(51) INT CL⁶

G05D 16/10

(52) UK CL (Edition O)

F2V VP11 VV12

(56) Documents Cited

GB 2184814 A

GB 2158198 A

(58) Field of Search

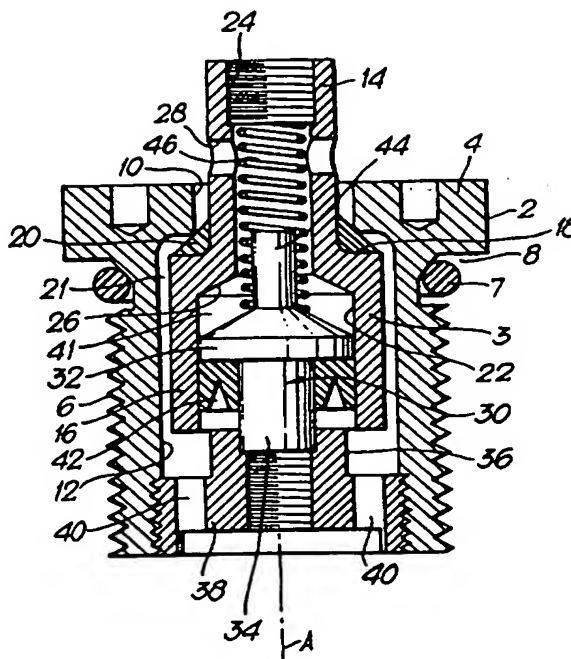
UK CL (Edition O) F2V VV12

INT CL⁶ G05D 16/10

(54) Pressure reducing valve

(57) In a valve for use in apparatus providing a relatively low regulated output gas pressure from a high pressure cylinder or the like, the valve is designed to provide a relatively large-diameter valve seating surface (20,) with a relatively small effective valve member cross-section, by forming the valve member (3), as part of a piston and cylinder combination defining therein a chamber (41) exposed to the low-pressure side of the valve. The valve seat or cooperating valve seating (20) may be made of an elastomeric material, with the cooperating valve seating or valve seat being in the form of a prominent ridge so that with increasing pressure differential on the valve, said ridge is driven progressively into the elastomeric material whereby the area of contact is progressively increased. These provisions allow variation in regulated pressure with variation in cylinder pressure to be minimised without overstressing the seating material of the valve.

Fig.1.



BEST AVAILABLE COPY

GB 2 298 026 A

1/5

Fig. 1.

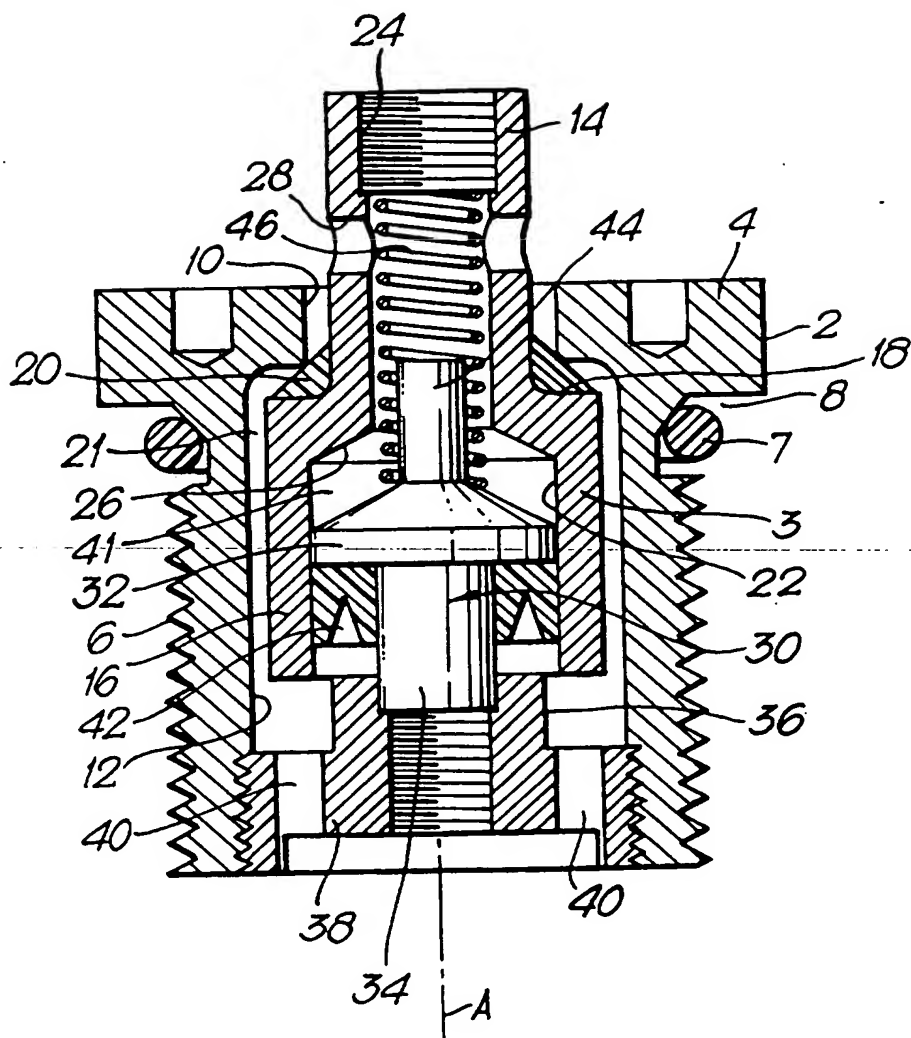


Fig.2.

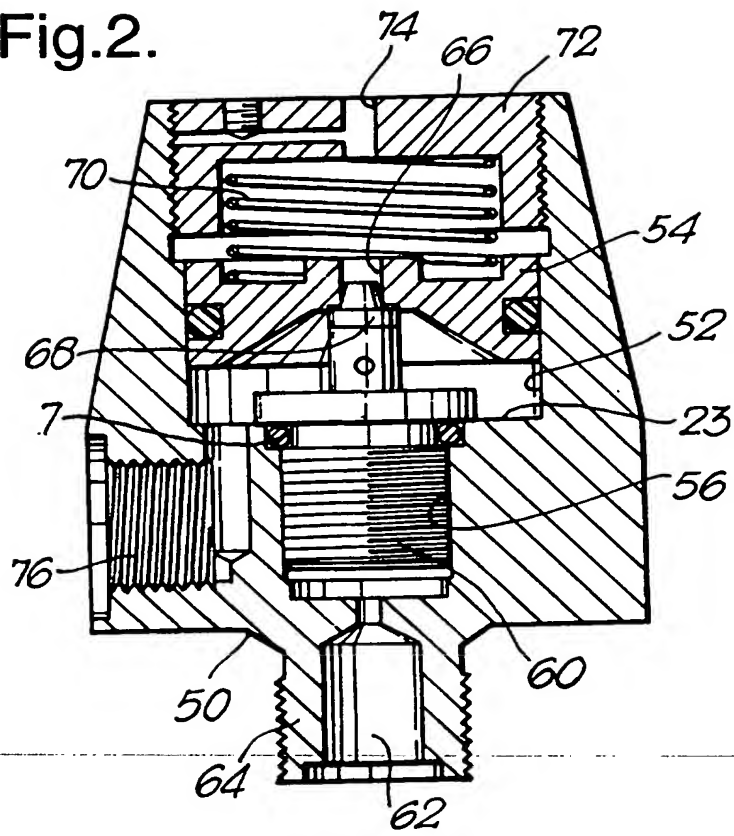
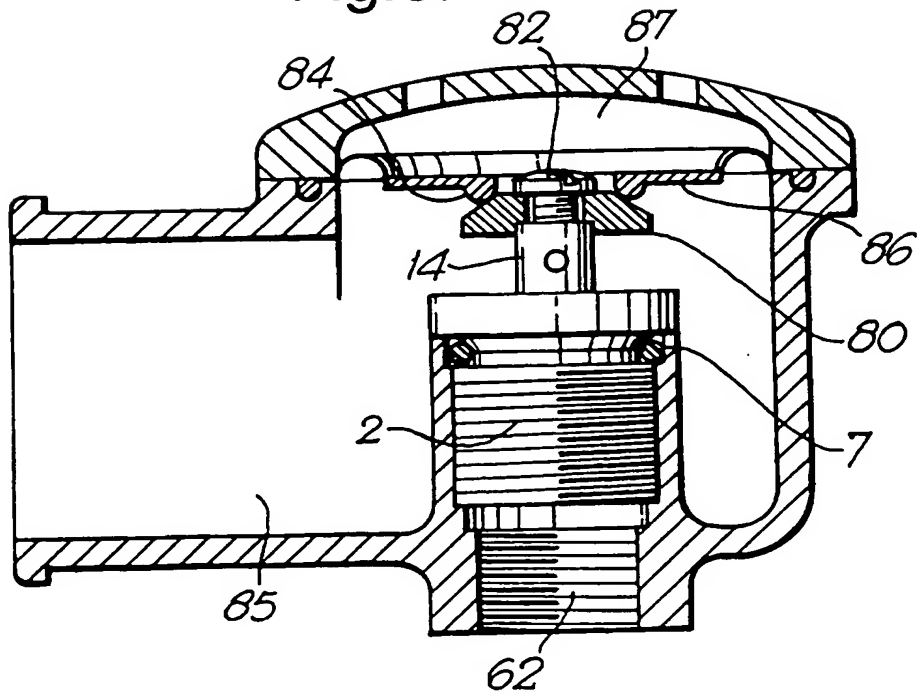


Fig.3.



3/5

Fig.4.

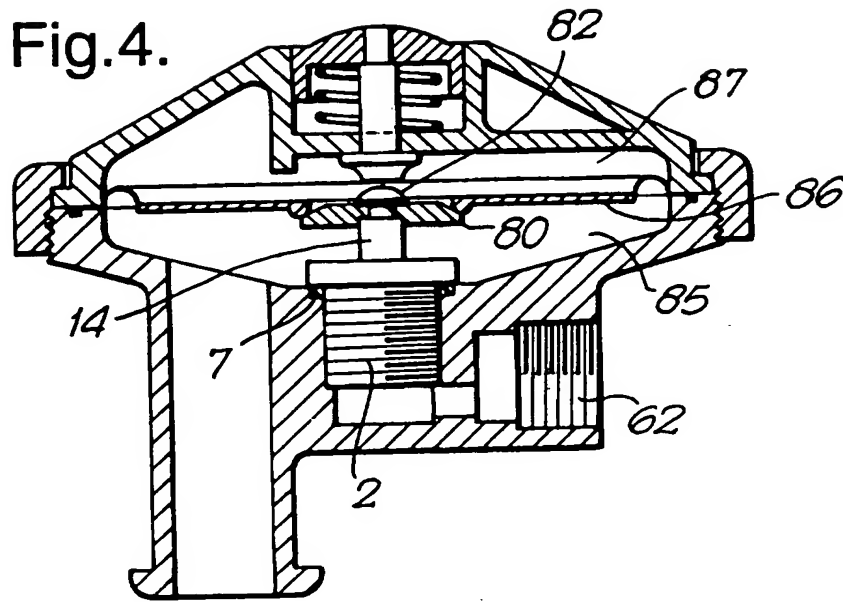


Fig.5.

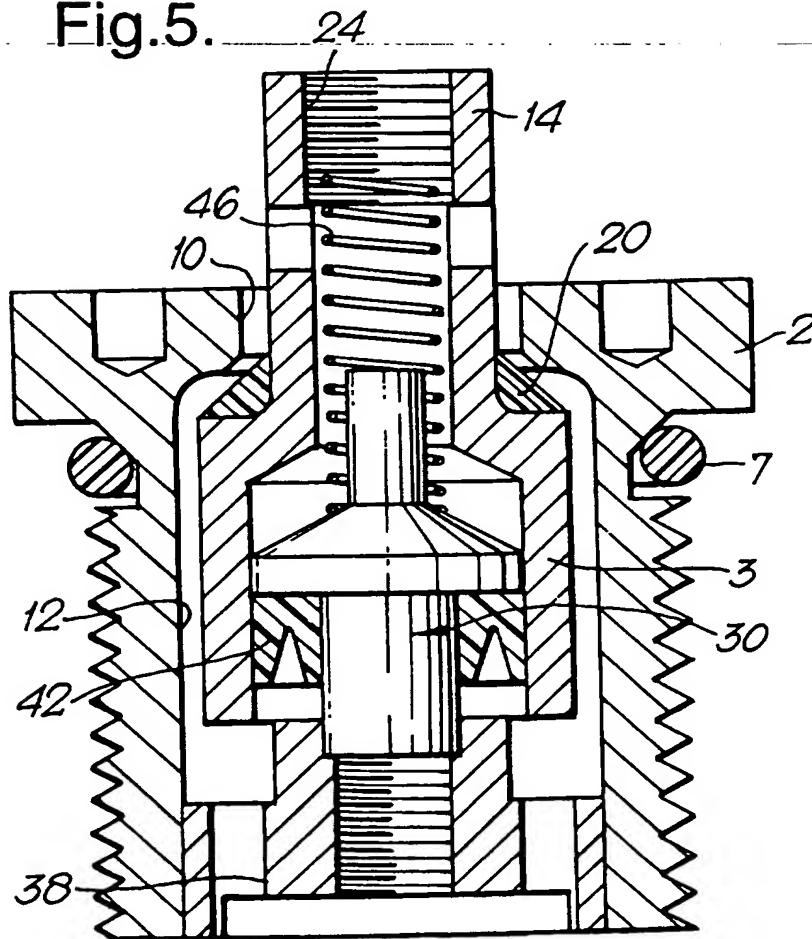


Fig.6.

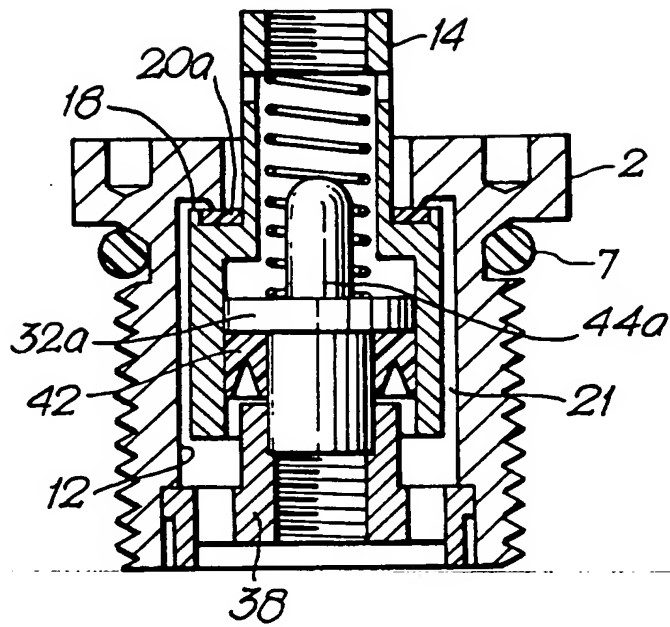
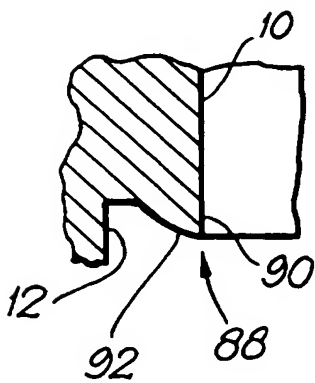


Fig.7.



DESCRIPTION OF INVENTION

Title: "Improvements on or relating to valves"

THIS INVENTION relates to fluid control valves, such as valves for the control of the flow of air or other gases, for example in pressure regulating and pressure reducing valves.

In the design of pressure regulators - or pressure reducers - the ideal is to provide an inlet valve which is in perfect balance when primary pressure is applied to an inlet connection, and the valve is in the closed condition. If this ideal state can be achieved, variation in the primary pressure will not affect the set pressure level. This is particularly critical when the pressure regulator is controlling pressurised gas supplied from a storage cylinder, where the primary pressure applied to the regulator is progressively reduced as the volume of air or other gas within the cylinder is used up.

In practical terms, where a pressure regulator is required to reduce primary pressures at relatively low levels - say, 300lb/in² high primary pressures, there is no problem. When controlling pressures in the range of thousands of pounds per square inch, it is generally difficult to obtain a balanced seal which is satisfactory for any dynamic balance arrangements which will not be either destroyed by the effects of the applied high pressure, or cause so much mechanical friction as to make the regulator inaccurate.

As a result of these factors, a regulator for reducing high pressures usually has to rely on an inlet

valve which is unbalanced and in which, therefore, the total area within the sealing line of the valve is exposed to the primary pressure, resulting in high closing thrust. The closing thrust can be reduced by reducing the poppet diameter and thus the effective sealing diameter of the inlet valve, but the result of reducing the diameter is to increase the stress in the seating material, and there is a limit to which such stress can be increased without destroying the seating material of the valve.

In a typical pressure reducing valve, a source of gas under high pressure (herein referred to as the primary pressure) is connected with a low pressure output, at which a desired regulated low pressure is to be maintained, via a poppet valve cooperating with a valve seat formed in a valve body. A reaction member, sealed at its periphery with respect to the valve body is urged towards the poppet by a load spring and is exposed, on its side facing the poppet, to the pressure on the low-pressure side of the poppet, (herein referred to as the secondary pressure).

The function of the load spring in such a pressure reducing valve or pressure regulator is to apply mechanical thrust to the sealed reaction member which, in turn, pushes on the poppet, to open the valve. As the valve opens, the secondary pressure rises. The consequent increase in gas pressure on the reaction member progressively overcomes the thrust of the load spring, until a balance is reached, and the inlet poppet closes, at the secondary, set pressure. When there is a demand from the secondary valve connection, the reduction in balancing thrust from the reaction piston against the thrust of the load spring, causes the poppet to open again. Thus, a pressure regulator is a force/balance system which works in a continuous state of adjustment and readjustment. In an ideal situation, the thrust required

from the load spring need be sufficient only to balance thrust from the reaction member, in terms of the set pressure; plus some small amount to overcome the effects of any mechanical friction.

However, some excess thrust is necessary to overcome any unbalanced closing effect of the primary pressure on the inlet poppet, and for an unbalanced, high pressure valve, this can be considerable. Where the primary pressure is provided by a cylinder of compressed gas, so that the primary pressure decreases progressively as the gas is released from the cylinder, this unbalanced closing effect decreases correspondingly with the primary pressure so that, at minimum cylinder pressure, the closing thrust provided by the primary pressure acting on the poppet will be greatly reduced. With a cylinder pressure declining from, say, 300 atmospheres to 3 atmospheres, the reduction is in the ratio of 100:1. Therefore, the load spring setting required to counteract the set pressure, plus the unbalanced closing thrust on the inlet poppet when the cylinder is full, will be substantially greater than that required at minimum cylinder pressure, where the closing thrust on the poppet is considerably less. Consequently, there is a steady increase in the nominally regulated set pressure on the lower pressure side of the poppet valve as primary pressure declines.

Conventionally, sensibly stable set pressure is achieved either by providing two pressure regulators in series, to reduce the pressure in two stages, or by providing a single stage system with the largest practical reaction area, combined with the smallest possible inlet valve (poppet valve) area, so that the change in unbalanced thrust between maximum and minimum is only a small

proportion of the high load spring thrust required to balance the set-pressure acting on a large area.

The problem with two stage pressure regulation is that as each stage valve has its own linear performance characteristics, the two independent sets of performance characteristics in series may interact adversely. The problem with the single stage solution is that for a high degree of accuracy, the physical size of the valve may be unacceptably large.

It is an object of the invention to provide an improved valve, which can avoid or mitigate the above disadvantages.

According to one aspect of the invention, there is provided a poppet valve comprising a valve port, a valve seat around the valve port, a valve member cooperating with the valve seat and displaceable along an axis passing through said port and having a stem extending through said port, and a shoulder for sealing engagement with said seat, and wherein said valve member has a bore extending into the valve member from an end thereof remote from said stem and communicating with an outlet from said stem, biasing means being provided biasing said valve member towards its closed position and wherein a piston is sealingly slidable in the said bore, whereby the effective area of said valve member acted on by the fluid pressure difference between said first and second sides of said valve is substantially reduced as compared with the area encompassed by said valve seat.

An embodiment of the invention is described below by way of example with reference to the accompanying drawing, in which:-

FIGURE 1 is a view in axial section of a valve module embodying the invention,

FIGURE 2 is a view in axial section of a pressure reducing valve incorporating a valve module in accordance with Figure 1,

FIGURES 3 and 4 are views similar to Figure 2 of other forms of valve incorporating valve modules in accordance with Figure 1, and

FIGURE 5 is a view, similar to Figure 1, of a variant of the valve module of Figure 1.

Referring to Figure 1, the valve module shown possesses substantial circular symmetry about an axis A in the plane of the drawing. The valve module comprises a hollow generally cylindrical body 2 including an end part 4 and an externally screw threaded portion 6 extending from end part 4 and of reduced diameter with respect to the part 4, whereby the peripheral region of part 4 forms an outwardly directed annular flange. A chamfered annular groove 8 is formed around the body 2, between the flange formed by the end portion 4 and the externally screw-threaded part of portion 6. A sealing O-ring 7 is received in this groove.

The body 2 has a stepped axial bore therethrough within which is accommodated a hollow valve member or poppet 3. This stepped bore includes a port 10 extending through end part 4 and a bore portion 12 which is of increased diameter with respect to port 10. The bore portion 12 extends to the end of body 2 remote from part 4 and has an internal screw thread over a region immediately adjacent the last-mentioned end of the body. The valve

member or poppet 3 includes a stem portion 14 which extends freely through the port 10 and a body portion 16 of larger diameter than the stem portion 14 and of larger diameter than the port 10. At its end nearer port 10, the bore 12 terminates in an internal shoulder which meets the port 10 in an annular edge or rim which forms a valve seat. The poppet 3 has, around its periphery, an annular shoulder 18 facing towards the valve seat and extending from the periphery of the stem portion 14 to the periphery of part 16. A seating surface of the poppet, for engagement with the valve seat, is provided by a ring or fillet 20 of elastomeric material received on said shoulder 18. As shown, this ring 20 of elastomeric material occupies the "corner" region between the shoulder 18 and the periphery of stem portion 14. The ring or fillet 20 presents, towards the valve seat, a surface which is generally frusto-conical about axis A.

The elastomeric material forming ring or fillet 20 may be applied initially in a liquid or fluid state and caused to cure *in situ* on the poppet 3, so as to be bonded thereto.

In a variant, not shown, the poppet 3 is made as a unitary body of an appropriate polymer, such as polyethylene, nylon or polyurethane. In this case, the form of the poppet may be substantially that of the poppet 3 plus fillet 20 of Figure 1, i.e. the fillet 20 may be formed as an integral part of the poppet rather than as a separately formed item. Such a unitary polymeric poppet may also be used in the variant of Figure 5, described below.

The larger diameter part 16 of the poppet 3 has a bore 22 extending axially from its end remote from the stem

portion 14. The stem portion 14 has an axial bore 24 of lesser diameter than the bore 22 and communicating with the bore 22. In the embodiment shown in the drawing, the bore 22 communicates with the bore 24 via a frusto-conical tapering bore section 26. The bore 24 is internally screw-threaded at its upper end (as viewed in Figure 1) to receive a tappet or other member (not shown in Figure 1 - see below) and a transverse bore 28 through the stem 14 provides communication between the bores 22, 24 and the low-pressure side of the valve.

Received as a close sliding fit in the bore 22 is a piston 30 having a head 32 and a cylindrical body 34 extending from the head 32 in the direction away from the valve seat, to engage a spigot portion 36 of a retaining insert 38, which is screw threadedly received in the internally screw threaded end portion of bore 12 remote from the valve seat. Holes 40 are provided through the region of the insert 38 between its periphery and the spigot portion 36 for the passage of the gas which the valve is intended to control.

The piston body 34 carries an annular seal 42 which seals the piston 30 with respect to the bore 22 of the poppet 3. A spigot 44 projects axially from the piston head 30 towards the narrower bore 24 of the poppet 3 and serves to locate one end of a biasing compression spring 46, the other end of which engages abutment means in the stem portion 14 of the poppet 3, for example the tappet or other member referred to above (not shown in Figure 1) screwed into the upper end of bore 24. The spring 46 thus urges the poppet 3, relative to piston 30, towards the valve seat. The spigot portion 36 of insert 38 is of a size to pass freely within the bore 22 in the poppet 3 so

as not to obstruct displacement of the poppet away from the valve seat.

The piston body 34 is, at its end remote from head 32, externally screw threaded and screwed into an internally screw threaded axial bore through insert 38 whereby the piston 30 is retained against movement relative to the body 2.

The seal 42 is preferably made of tough P.T.F.E. and ensures effective sealing between the piston 30 and the poppet 3 whilst affording little friction between the seal 42 and the poppet 3, even at high primary pressures. Consequently the spring 46 need only be a light spring. For pressures up to 300 lbs per square inch, the design of the piston 30 may be modified to receive an O-ring as a sealing member between the piston 30 and the poppet 3, the latter sealing arrangement being less expensive than the P.F.T.E. or similar type of seal of the kind illustrated in Figure 1.

In use of the valve module shown in Figure 1 (and as will appear from the description below with reference to Figures 2 to 4) the space 21 within the bore 12 and extending around the exterior of portion 16 of the poppet 3 is exposed to the high or primary gas pressure, and is thus on the high pressure side of the valve module, whilst the bore 24 and the external face of part 4 facing away from portion 6 is exposed to the low, secondary, set or regulated gas pressure, and are thus on the low pressure side of the valve module.

In the arrangement shown, the diameter of the bore 22 is substantially equal to that of the port 10 (i.e. to the inner diameter of the valve seat), so that, when the

valve is closed, the gas pressure on the low pressure side of the valve module produces no net force parallel to the axis A on the poppet 3 and likewise, neglecting the finite width of the valve seat, the gas pressure on the high pressure side of the valve module produces no net force parallel to the axis A on the poppet 3. The valve is thus, in principle, balanced. At the same time, the diameter of the valve seat is substantially larger than would be practicable for an unbalanced valve, in many applications, allowing for substantially greater gas flow rates. Accordingly, a small complete inlet valve assembly or module, of the kind described with reference to Figure 1, can serve a wide range of pressure regulator requirements and, being in modular form, can be assembled and tested independently of any valve body into which it may be eventually fitted.

The assembly shown in Figure 1 comprises a prefabricated module which can be readily fitted into a wide variety of pressure regulating valves or demand valves designed to receive the module. The bore 24, adjacent the free end of stem 14, may be internally screw threaded to receive any of a variety of fitments according to the intended use of the valve. It is thus possible for the prefabricated module of Figure 1, (or the variant of Figure 5, described below) to be manufactured and fully tested by a specialist manufacturer and supplied to various different manufacturers of pressure regulating valves, demand valves, etc. for fitting in the latter.

Referring to Figure 2, a pressure regulating valve is illustrated having a body 50 providing a cylindrical chamber 52 in which a reaction member or piston 54 is sealingly slidable. A screw threaded bore 56 extends from an end wall 58 of chamber 52 and receives a valve module 60

such as the valve module described with reference to Figure 1, the externally threaded portion 6 of the body 2 of the module being screwed into the bore 56. When the module is fitted in the valve body 50 as shown in Figure 2, the O-ring 7 is received in an annular rebate formed around the bore 56 between the end wall 58 and the screw threaded portion of bore 56, thereby sealing the body 2 with respect to the body 50. The lower end of the bore 56 communicates with an inlet port 62 in an inlet coupling 64 adapted to be screwed into a discharge fitting of a compressed gas cylinder, for example. The reaction member 54 has a central aperture 66 therethrough via which, in certain positions of the valve as described below, gas can vent from the chamber 52. A valve member 68 having a stem (not shown) screwed into the upper end of stem 14 cooperates with the aperture 66 and normally seals off the aperture 66. The reaction member 54 is urged towards the valve module and thus towards engagement with the valve member 68 by a compression spring indicated schematically at 70. The spring 70 is held in compression between the reaction member 54 and a cap 72 screwed into an internally threaded enlarged upper portion of the bore 52. As shown, the cap 72 has an aperture 74 therethrough for venting purposes. An outlet passage 76 for gas communicates with the interior of chamber 52. In operation, if the pressure in chamber 52 falls below a predetermined level determined by the spring 70 (as a result of gas being drawn from the chamber 52 via the port 76) the spring 70 displaces the reaction member 54 and thus, via the valve member 68, the poppet 3 of the module 60 downwards as viewed in Figure 2, thereby displacing the poppet seal 20 from the cooperating valve seat and allowing gas under pressure, from inlet 62, to pass into the chamber 52, thereby raising the pressure in chamber 52 to counteract the tendency of the spring 70 to displace the reaction member 54 downwardly. If, as a

result of some fault in the valve module 2, for example, as a result of the seal 20 failing to seat sealingly on the valve seat, gas under pressure should continue to leak through the valve module into the chamber 52 despite the pressure in chamber 52 being at or above the preset pressure, the reaction member 54 will be forced upwardly so as to disengage the valve member 68 from its sealing engagement around the lower end of aperture 66, allowing excess pressure to vent through the aperture 66 past the valve member 68.

Figures 3 and 4 illustrate valve modules of the same form incorporated in demand valves. Figure 3 illustrates a demand valve for a breathing apparatus suitable for firefighters, for example, whilst Figure 4 illustrates a demand valve for a diving system. In the arrangements of these figures, the upper end of the stem 14 carries a chamfered annular valve plate 80 secured to the upper end of the valve stem 14 by a retaining screw 82 screwed into the valve stem. The frusto-conical surface of the valve plate 80, in each case, cooperates with an annular sealing bead 84 around a central aperture in a diaphragm 86 which divides a chamber provided within the valve body into a first region 85, in communication with the low pressure side of the valve module and a venting chamber 87 on the opposite side of the diaphragm 86 from the valve plate 80. In each case, the valve module body 2 is screwed into a complementary screw threaded bore provided in the body of the valve proper and is sealed with respect thereto by the O-ring 7 in substantially the same way as described in relation to Figure 2.

Figure 5 illustrates a variant of the valve module of Figure 1 (to an enlarged scale as compared with Figure 1). In this variant, the valve seat with which the seal 20

around the poppet 3 cooperates, instead of being formed as an abrupt edge where the shoulder at the upper end of bore 10 meets the bore 12, is bevelled as shown (or alternatively may be convexly radiused as viewed in axial section, so that the seat surface is of compound form). It has been found that the effect of this feature, in combination with the elastic properties of the seal 20 is to decrease the effective inner diameter of the annular region of contact between the seal 20 and the valve seat as the force urging the poppet 3 towards the inner diameter of the valve seat decreases, whereby the valve becomes decreasingly balanced, (and possibly even negatively balanced). This has been found unexpectedly to improve the operating characteristics of the valve. It will be appreciated that the same principle may be applied to poppet-type valves of other types and is not confined to balanced or near-balanced valves of the type shown in Figures 1 and 5.

The tapered seat configuration used in the embodiments of Figures 1 to 5 is preferable for efficient gas flow past the poppet. However, such a configuration can present some practical difficulties from a constructional point of view and as regards mechanical function. In the embodiment of Figures 1 to 5 as described above, the poppet and valve seat are so configured that progressive deformation of the tapered seat under high mechanical stress and high pressure does not upset the balance of the valve adversely. However, such deformation can, under some circumstances, cause a mechanical wedging effect, which may inhibit opening of the valve. In addition, the tapering seat configuration is intolerant of departures from strict concentricity of the poppet with respect to the valve seat or of any mechanical guide means which may be provided for guiding the poppet in its

movement towards and away from the seat, with respect to either the poppet or the seat. To be effective, mechanical guidance for a tapered poppet requires close manufacturing tolerances in respect of the mating diameters, and a high standard of concentricity. This can be costly in manufacturing terms, for some uses.

For many applications, a tapered poppet form can also be very critical as regards seat material. Thus, the seat material must be sufficiently deformable to make a leakproof seal, yet must be able to resist excessive deformation under high applied gas pressure, notwithstanding any beneficial influence which the progressive seating contact radius may have. For example, should the tapered poppet material be relatively soft, the gas pressure can apply a radial "squeeze" to the exposed surface of the poppet seat material which, if it is not truly homogeneous, can result in uneven deformation, causing subsequent local leakage.

The embodiment of the invention shown in Figures 6 and 7 employs a form of poppet seating surface which is substantially planar, cooperating with a valve seat in the form of an annular rib facing the poppet seating surface.

Thus, in the embodiment of Figure 6 and 7, in which parts corresponding to parts in Figure 1 have the same references, the annular shoulder 18 of the poppet valve member supports a flat annular elastomeric sealing member 20a, for example located in a shallow annular groove in the shoulder 18, and the opposing valve seat is afforded by an annular rib projecting towards the elastomeric sealing member 20a from the end wall of the larger diameter part 12 of the axial bore in body 2. As shown to an enlarged scale in Figure 7, this rib, referenced 88, has a substantially

cylindrical radially inner surface 90 coaxial with the remainder of the valve and formed as a continuation of bore 10 and has a radiused radially outer surface 92, (radiused as viewed in the axial section view of Figure 7), whereby the radially outer surface 92 is part-spherical or quasi-spherical. This partly spherical and partly cylindrical form of the valve seat provides a relatively sharp annular contact edge region to ensure accurate dimensioning, and to provide optimum and consistent dynamic balance. The partly spherical form provides a limited increase in sealing annular contact area to a proportional degree, as mechanical closing forces cause penetration of the annular rib into the elastomeric seating material 20a. The edge region between the cylindrical surface and the quasi-spherical surface is slightly radiused or "blunted" to avoid damage to the polymeric seating material 20a. The deformation resistance of any chosen seat material 20a in this embodiment is a function of the choice of radius of the seating, and the point from which it is struck. In Figure 7 the radius is struck, for purposes of illustration, from a point just inside the bore 10 of the outlet orifice.

The optimum relative sharpness of the sealing edge of the seating 88 is a function of the mechanical loading due to dynamic effects, and the degree of possible deflection of the seat material. For low applied gas pressures of, say, 4 ats., a sharp edged seating 88 and a relatively soft elastomeric seat 20a will provide a satisfactory combination. For higher pressures in, say, the 100 bar range a slightly broken or blunted seating edge of, say, 0.05mm radius, (as viewed in axial section) with a hard elastomeric seat 20a would make a good initial design approach, whilst for very high applied gas pressure of 200 bar or more, a sharp edged seating 88 combined with

a thermoplastic type of seat material 20a, such as, for example, polyethylene or PVC, would make a more likely combination of mating materials; with the hard seat material 20a serving to resist penetration, whilst the sharp edge 88 provides sufficiently high sealing stress.

In the embodiment of Figure 6, the piston 30 also has a planar annular shoulder between the piston head (referenced 32a) of the piston 30 and the spigot (referenced 44a), which projects upwardly from head 32a into the stem 14.

Figure 8 (in which parts corresponding to parts in Figures 1 and 2 have like references) illustrates an embodiment incorporated in a three part pressure regulating valve operating on the same principles as the pressure regulator of Figure 2. In the embodiment of Figure 8, however, the valve member (referenced 3a) does not have a stem extending through the port 10 but instead has a flat upper surface acted on by a hollow stem 93 of a reaction-member 54a, (corresponding in function with the reaction member 54 of Figure 2) the stem 93 projecting through port 10 to engage the upper surface of the valve member 3a. The valve member 3a carries a flat disc-like seating 95 which provides the major part of the upper surface of the valve member and which cooperates with a valve seat provided around the lower end of stem 93 as well as with a valve seat in the form of a prominent annular rib 88, of the same form as the rib 88 in Figures 6 and 7 and which is likewise provided, around the port 10, on the end wall of the part 12 of the bore which receives the valve member 3a. The disc-like seating 95 is provided with a feed-back orifice in register with a passage 94 extending in the valve member 3a to the underside of the valve member 3a. Figure 8 also illustrates an alternative piston and cylinder arrangement

(relative to the arrangement shown in Figure 1), to provide dynamic balance for the poppet. Thus, in this arrangement, the valve member 3a itself forms a piston sealingly slidable in a cylinder 96 screwed into the lower end of the housing 2, and forming a closure plug for the housing 2, the piston-like valve member 3a thus defining, with the cylinder 96, a further chamber 41a below the valve member and with which the passage 94 communicates, for example, through an axially bored retaining screw 98 screwed into a lower end of passage 94, said retaining screw serving to retain a retaining plate 100 for a piston seal 42a carried by the valve member and sealingly engaging the interior wall of cylinder 96. A compression spring 46a within cylinder 96, below the valve member 3a, urges the member 3a upwardly into engagement with the valve seat 88. Thus, in this arrangement, the piston seal is fitted to the valve member, and slides up and down in the bore formed in the static cylinder 93. The airflow pattern in this third embodiment differs from that in the previous embodiments in that the inversion of the balance seal function requires the primary pressure to be fed to a point above the piston seal. Therefore the flow path is routed through spaces 102 provided between the module body 2 and the body 50a of the valve unit into which the module 2 is fitted, and thence through radial holes 104 in the body of the module 2.

In the arrangement shown in Figure 8, when the reaction member 54a and with it stem 90 is lifted from valve member 3a, air from the chamber on the low pressure side of the valve is exhausted by way of the passage within the hollow stem 93 and via the reaction piston 54a of the valve. The passage within hollow stem 93 terminates in the above-mentioned valve seat formed around the lower end of the stem, which valve seat cooperates with a central region of the flat seating 95. An arrangement similar to that of

Figure 8 can also be used in a two-port pressure regulator, in which no provision is made for venting the low-pressure side of the valve through the counterpart to the reaction member 54 or 54a. In such a two-port regulator, the stem corresponding to stem 93 does not need to have an exhaust passage extending therethrough and thus can be smaller in diameter than is required to accommodate the exhaust passage in the hollow stem 93 illustrated, thus providing enhanced gas flow from the same size of module.

It will be appreciated that, in the various embodiments described above, the valve seat formed around the bore 10 and the elastomeric or plastics seating or seal 20, 20a, 95 may be transposed, with the elastomeric or plastics seating carried by the body 2 and cooperating with a rigid annular seating rib or edge carried by the valve member 3 or 3a. The elastomeric or plastics seating or seal 20, 20a or 95 may be formed of any suitable materials, such as polyurethane, polyethylene or nylon, according to the desired seating characteristics and the form of the cooperating valve seat, as described above.

Whilst the preferred embodiments described above are intended for the control of air or other gases under pressure, it will be appreciated that valves in accordance with the invention will work with liquids and the appended claims are intended to encompass such valves controlling liquids.

CLAIMS

1. A valve including a chamber accommodating at least part of a valve member, said chamber forming at least part of a first or high pressure side of said valve, a valve port leading from said chamber to a second or low-pressure side of said valve, a valve seat around the valve port, said valve member having a seating surface cooperating with the valve seat and the valve member being displaceable, along an axis passing through said port, respectively

(a) in a first direction, to move said seating surface into said chamber and away from said valve seat and

(b) in a second, opposite direction, to move said seating surface towards said valve seat,

the valve member

(c) forming a piston sealingly slidable, in said first and second directions, in a cylinder to define therewith a further chamber or

(d) forming a cylinder sealingly slidable, in said first and second directions, on a piston to define therewith a further chamber,

biassing means being provided biassing said valve member in said second direction towards its closed position,

said further chamber in either case communicating with the low pressure side of the valve, whereby the effective area of said valve member acted on by the fluid pressure difference between said first and second sides of said valve is substantially reduced as compared with the area encompassed by said valve seat.

2. A valve according to claim 1 which is in the form of a poppet valve, said valve member having a stem extending through said port, and a shoulder, having said

seating surface, for sealing engagement with said seat, and wherein said valve member has a bore extending into the valve member from an end thereof remote from said stem and communicating with an outlet from said stem, and wherein a piston is sealingly slidable in the said bore to define therewith said further chamber, whereby the effective area of said valve member acted on by the fluid pressure difference between said first and second sides of said valve is substantially reduced as compared with the area encompassed by said valve seat.

3. A poppet valve according to claim 1 wherein the cross-sectional area of said piston received in said bore in said valve member is substantially equal to the area encompassed by said valve seat.

4. A valve according to claim 2 or claim 3 wherein said piston is fixed with respect to said valve seat.

5. A valve according to any of claims 1 to 4 which is provided within a module comprising a hollow body providing an internal passage defining at least part of said chamber and accommodating said valve member and providing said valve seat and said port, the valve including retaining means secured in said body and serving to retain said valve member within said body and said piston within said valve member, or said cylinder around said piston, said body being adapted to be removably received within a complementary recess in a larger assembly.

6. A valve according to any preceding claim wherein said biasing means comprises a spring acting between said piston and said valve member.

7. A valve according to any preceding claim wherein said valve member is formed as a unitary body of a polymer.

8. A valve according to claim 7 wherein said polymer is polyethylene.

9. A valve comprising a valve port providing communication between a first side of the valve and a second side, a seat around the valve port and facing generally towards said second side of the valve, a valve member cooperating with the valve seat and displaceable along an axis passing through said port, the valve having a seating portion, facing towards said valve seat, for sealing engagement with said valve seat, and wherein one of said valve seat, or said seating surface is provided by an elastomeric material, and the other of said valve seat on said seating surface has an effective edge region which is bevelled or radiused so that the area encompassed by the regions of contact of the elastomer with said edge region or the area of contact of the elastomer with said edge region, will vary with the force urging the valve member towards the valve seat.

10. A poppet type valve comprising a valve port providing communication between a first side of the valve and a second side, a seat around the valve port and facing generally towards said second side of the valve, a valve member cooperating with the valve seat and displaceable along an axis passing through said port, the valve having a stem extending through said port along said axis and a shoulder on said second side of the valve port, facing towards said valve seat, for sealing engagement with said seat, and wherein the surface of said shoulder which cooperates with the valve seat is provided by elastomeric material and wherein said valve seat has an effective edge

region which is bevelled or radiused so that the area encompassed by the regions of contact of the elastomer with the valve seat, or the area of contact of the elastomer with the valve seat, will vary with the force urging the valve member towards the valve seat.

11. A poppet valve according to claim 10 wherein the surface of the valve seat which cooperates with the valve seat is a tapering or bevelled surface.

12. A valve according to any of claims 9 to 11 wherein the surface of said elastomer which cooperates with the said edge region is a substantially planar surface and wherein the cooperating valve seat or seating surface takes the form of a prominent annular rib facing towards said planar surface.

13. A poppet type valve comprising a valve port providing communication between a first side of the valve and a second side, a seat around the valve port and facing generally towards said second side of the valve, a valve member cooperating with the valve seat and displaceable along an axis passing through said port, the valve having a stem extending through said port along said axis and a shoulder on said second side of the valve port, facing towards said valve seat, for sealing engagement with said seat, said valve member being a unitary member of a polymeric material, and said surface of said shoulder which cooperates with the valve seat is a tapering or bevelled surface provided by said polymeric material and wherein said valve seat has an effective edge region which is bevelled or radiused so that the area encompassed by the regions of contact of the polymeric material with the valve seat, or the area of contact of the valve member with the

valve seat, will vary with the force urging the valve member towards the valve seat.

14. A valve according to claim 13 wherein said polymeric material is polypropylene.

15. A poppet type valve substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

16. Any novel feature or combination of features described herein.



Application No: GB 9602817.0
Claims searched: 1 to 8

Examiner: Alan Blunt
Date of search: 26 April 1996

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2V (VV12)

Int Cl (Ed.6): G05D 16/10

Other:

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	GB2184814A (BRAKE) - Figure 1 - spring 36 biases valve member closed	1
X	GB2158198A (BRAKE) - Figures 1a,1b	1

X Document indicating lack of novelty or inventive step
Y Document indicating lack of inventive step if combined with one or more other documents of same category.
& Member of the same patent family

A Document indicating technological background and/or state of the art.
P Document published on or after the declared priority date but before the filing date of this invention.
E Patent document published on or after, but with priority date earlier than, the filing date of this application.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☒ FADED TEXT OR DRAWING
- ☒ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.